Pretzel Tying Machine

By RUSSELL G. ZUEFLE, Product Engineer

Reprinted from

July 1949

AMERICAN MACHINE & FOUNDRY COMPANY

485 FIFTH AVENUE, NEW YORK 17, N. Y.

Pretzel tying machine

duplicates motions of hands and fingers

By Russell G. Zuefle
Product Engineer
American Machine & Foundry Co.
Buffalo, N. Y.

FOR MANY centuries, the salty little biscuit known as a pretzel has been fashioned by hand in substantially the same form that we see it today. So persistent has been the public demand for the traditional shape with a twist in the center and a loop on each side, that many attempts have been made to simplify the arduous work of tying the billions of knots now required annually. Although both die-stamped and extruded pretzels are being marketed, the manual process is actually duplicated in the American Machine and Foundry Co. pretzel tying machine. Metal fingers replace those of the crafts-

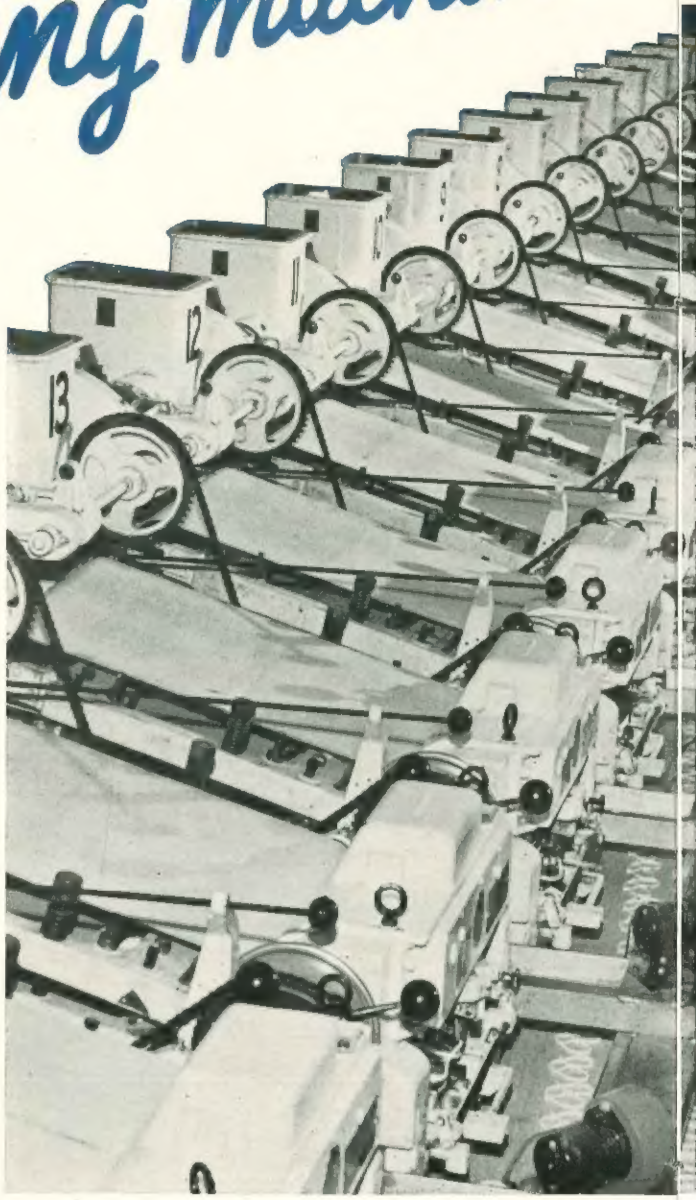


Fig. 1—Right—Pretzel tying units installed diagonally across an endless belt. Each unit feeds a row of pretzels to the baking oven

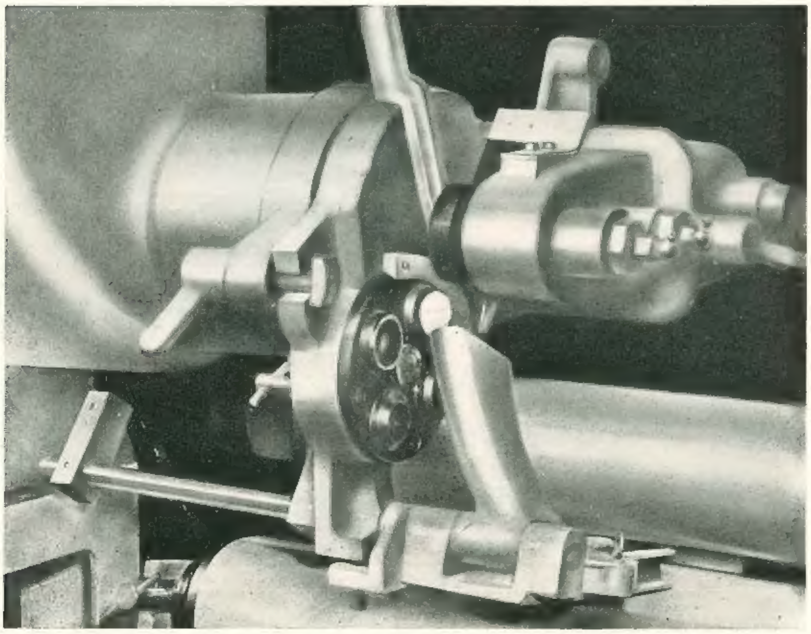


Fig. 2—Below—Extruded dough, cut off as pellets by the rotating knife, is rolled between canvas belts to form dough rods

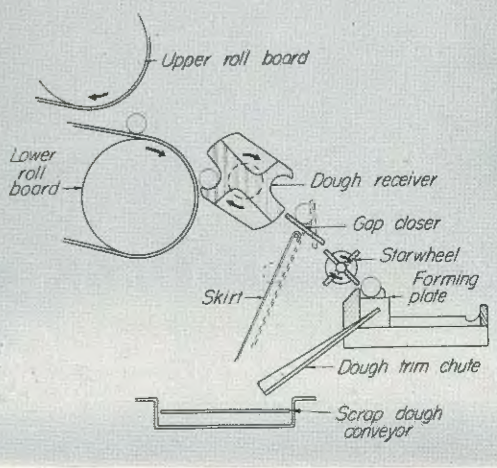


Fig. 3—Below—Transfer point where dough rod is fed into tying mechanism. Rejected dough rods and end trimmings, carried away by scrap conveyor, are put back in extruder

man, to grasp uniform-sized rods of dough and twist them into the identical knot and shape that have always characterized pretzels.

Illustrated in *Fig.* 1 is a battery of these pretzel tying machines. Each will transform a mass of dough into raw pretzels and deliver them to a moving conveyor at rates up to fifty-five per minute, twenty-four hours per day. In a typical application, sixteen such machines are mounted diagonally across a fifty-inch wide conveyor belt which carries the sixteen rows of pretzels to the cooking and baking process. Such a battery of machines will produce over four-hundred-thousand pretzels in an eight-hour day, which represents from four to seven thousand pounds of finished product, depending on the diameter of the dough rods fed to the tying heads. Weight of the pretzels is determined primarily by this dimension, as they are otherwise uniform in size and shape. By adjusting the spacing between the rolling belts which produce the rods, weights from 55 to 105 to the pound of finished product can be obtained.

Employs Battery of Unit Machines

Prominent feature of this use of multiple units is the high mechanical availability that can be achieved. A breakdown in one unit can be remedied quickly by inserting in its place a spare tying head, resulting in a minimum loss of production while repairs are being made. Each tying unit is powered through a three-jaw clutch coupling to the main line shaft, so that any one unit can be shut down independently of the rest of the battery. This shaft is supported on self-aligning bearings at each unit and is driven by a Reeves 15-hp variable-speed drive mounted at whichever end of the supporting structure suits the bakery layout best.

To facilitate quick interchange of tying heads, aluminum has been used for the supporting frames,

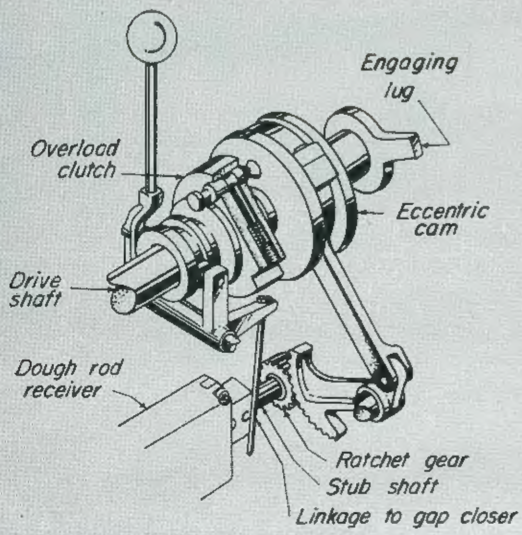


Fig. 4—Left—Detail of right-hand side of tying head, showing engaging lug, dough rod receiver drive and overload cluch

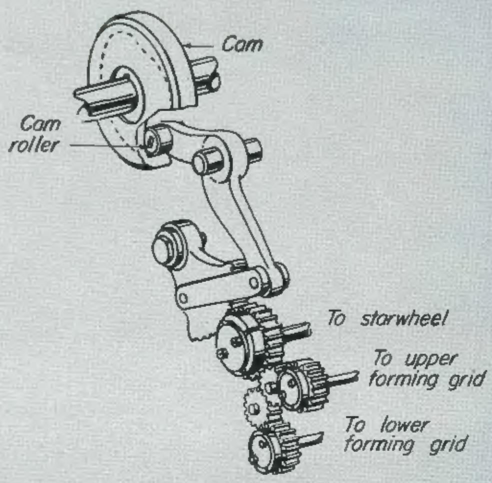


Fig. 5—Right—Left-hand side of tying head, showing generation of starwheel and upper and lower forming grid motions

gear boxes, covers and shrouding. Weight considerations were sacrificed, however, in the design of the main cams and other working parts to achieve sturdiness and long life.

In operation, the dough mixture is placed in the hopper of a screw type extruder, *Fig.* 2. A rotating selector plate provides four different sized orifices to determine the volume of the pellets from which the dough rods are formed. A lever-operated gate on the inside surface of the extruder end-plate provides a fine adjustment of this pellet volume. These adjustments, in conjunction with the variable spacing of the rolling belts, determine the length and diameter of the dough rods prior to entry into the tying mechanism.

The relationship of the tying head and rolling belts is shown in *Fig.* 3. Since the dough-rod receiver, which is part of the tying head, must be placed as close as possible to the surface of the belts without touching them, the interchangeable tying heads are located by dowel stops in the supporting structure and a machined surface on the frame of the tying head. This permits the use of large slots in the tying heads for easy placement of two tie-down bolts.

A single engaging lug, at the right-hand end of the tying-head cam shafts, slides between two bronze bushings mounted on studs brazed into the driven face of a friction clutch at the right of each machine, *Fig.* 4. Roller chain is used to drive this clutch from a countershaft underneath the rolling belts. and also powers the dough extruder and pellet cutting knife as well as the rolling belts themselves. By momentarily slipping the friction clutch, the tying head can be timed to index with the arrival of a dough rod in the dough receiver. Once timed, the adjustment needs no further attention unless the diameter of the dough rods or the viscosity of the dough mix is changed.

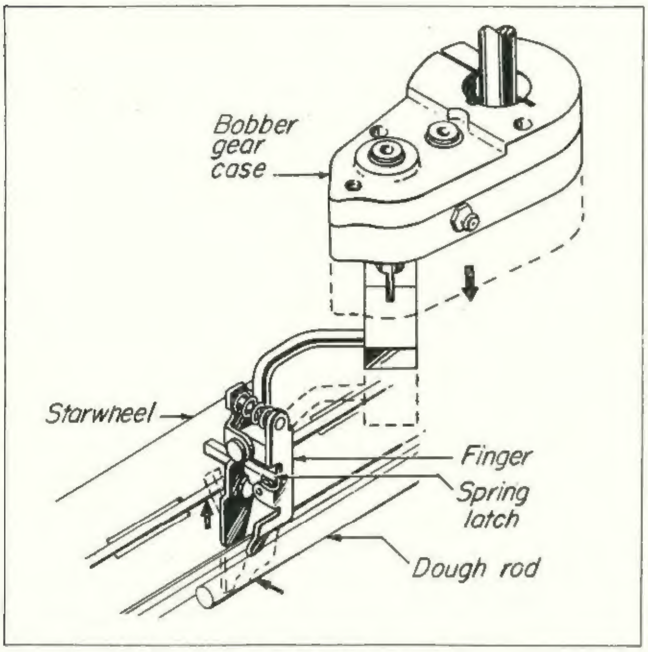
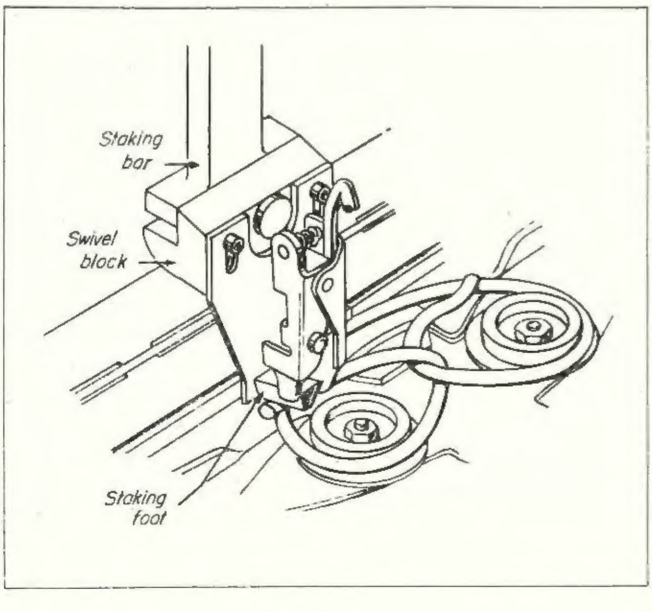


Fig. 6—Above—Lowering of the bobber gear case trips the latch lever of the finger against the starwheel to grasp the dough rod, starting the tying operation

Fig. 7—Below—Staking bar descends to press staking foot over the end of dough rod, welding it to body of pretzel. Finger is latched open by the staking foot



Receiver Stretches Dough Rod

Dough rods are transferred from the rolling belts to the tying head by indexing of the dough-rod receiver, *Fig.* 3. This part is an aluminum casting with two grooves positioned one hundred eighty degrees apart and curved convexly over the length of the rod receiver. Shaping the grooves in this manner tends to stretch out the rolled rod of dough and removes any kinks caused when the rotating rod is released from the pressure of the belts. It also compensates for the tendency of the dough rods to drop ends-first from the belts, which is brought about by crowning of the belt pulleys.

A stub shaft, running in needle bearings in each side frame, supports the ends of the dough-rod receiver. The right-hand stub shaft indexes the receiver one hundred eighty degrees for each revolution of the tying head camshaft. An eccentric cam on the input side of a combination manual and overload-operated clutch generates this motion through the segment and ratchet gear linkage shown in *Fig.* 4. The left-hand stub shaft controls the positioning of the receiver by means of a spring-loaded pin, which drops into a groove ground in the shaft.

Mechanism Has Light Loading

A graphitic tool steel is used for this detent shaft and is giving excellent wear despite adverse lubrication conditions, caused by the presence of edible oils, flour and salt. Spring loading of the detent pin is less than one pound, which is sufficient to stop the forward motion of the receiver, yet permits the pin to be cammed out of the detent on the forward stroke of the ratchet gear without excessive side thrust on the pin sleeve.

Referring again to *Fig.* 3, the dough rod leaves the

receiver groove at the end of the receiver index and is transferred to a starwheel if the gap closer plate is in the closed position. This plate is elevated to the position shown in dotted outline to reject the rods from the tying mechanism. Dough, so rejected, is deposited on a four-inch canvas conveyor running the length of the structure and is collected for reuse in the machine. A linkage to the overloaded clutch elevates this transfer plate automatically when the clutch is disengaged to prevent pile-up of the dough in the starwheel, since the dough receiver, being driven from the input side of the clutch, continues to operate as long as the timing clutch is engaged.

Cam Indexes Starwheel

Indexing of the starwheel is accomplished in the same manner as that of the dough-rod receiver but, in this instance, power is taken from a closed-track cam, *Fig.* 5, on the left-hand end of the main camshaft. Since the starwheel indexes only ninety degrees per pretzel, the ratchet gear is larger to make possible the indexing of upper and lower pretzel forming grids by means of the gear train shown in *Fig.* 5. Dough rods are deposited directly onto the platen of the upper forming plate and grid with each index of the starwheel.

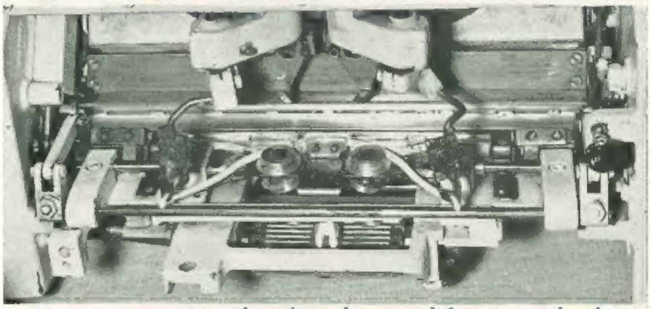
A trimmer knife at each end of the platen cuts off the execess length of the dough rod simultaneously with descent of the tying fingers. These scrap ends are also dropped down chutes to the same scrap-dough conveyor which carries away rejected dough rods.

Details of the stainless-steel tying fingers and their assembly to a bobber case are shown in *Fig.* 6. Both fingers arrive over the ends of the dough rod latched in their open position. Downward motion of the bobber case unlatches a spring-loaded hinge on the fingers to grasp the dough rod, while the downward motion of a staking foot, *Fig.* 7, at the opposite end of the finger travel, relatches them in the open position.

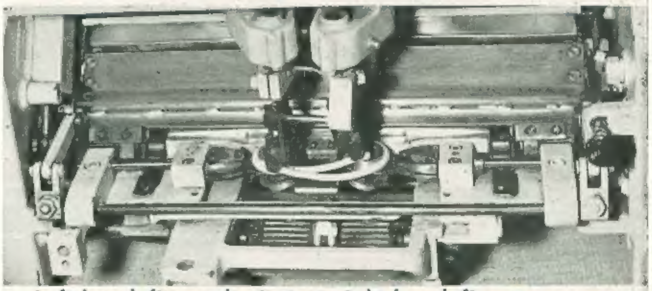
The two loops of the pretzel are bent around a pair of stainless steel forming wheels on each side of an indexing upper grid plate. Since an actual cross over in the path of the left and right-hand fingers is required to tie the knot, backlash must be held to a minimum throughout a long gear train from cams to fingers. Crossing of the finger path is accomplished by first moving the bobber cases through approximately ninety degrees to a position at right angles to the tying platen while revolving the finger mounting arms about their pivot point at the ends of the bobber cases. The left-hand finger hesitates momentarily, while the right-hand finger swings the dough rod over the loop held by the left-hand finger, continuing through to stake the end in place, which forms the right-hand loop. It then retraces its arc in

Fig. 8—Right—Progressive positions of fingers in tying and staking the pretzel knot

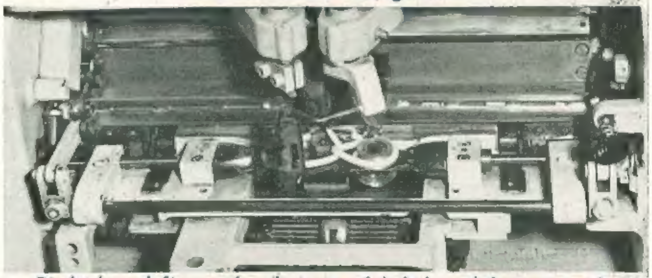
Fingers ready to grasp dough rod. Lower plate is starting to deposit previously tied pretzel



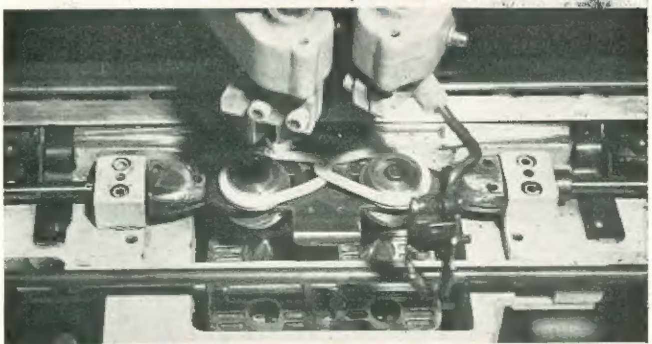
Fingers wrapping dough rod around forming wheels



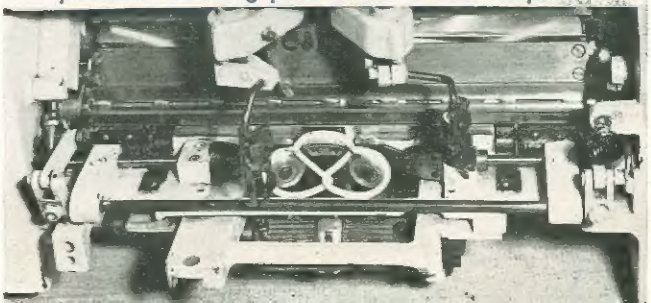
Left-hand finger hesitates; right-hand finger crosses over left end of dough rod



Right-hand finger backs out of left-hand finger path to allow it to complete its arc



Above—Left end of dough rod being staked
Below—Fingers latched open, returning to pick-up position. Forming plate index is half complete



time to allow clearance for the left-hand finger. At this time, the left-hand finger completes its arc and the left-hand stake bar comes down to open the finger and complete the left-hand loop. Both bobber cases descend at each end of the finger travel to alternately pick up and deposit the ends of the dough rod. *Fig.* 8 illustrates six progressive positions of the fingers required in tying a pretzel.

Immediately after the pretzel is thus formed, the upper forming grid rotates one hundred eighty degrees, and the pretzel is deposited upside down on a lower forming grid. This second grid performs the function of tightening the knot after release of the two loops from the upper forming grid wheels. It also serves to place the pretzel on the conveyor in the best attitude for baking with the staked ends of the dough rods up, since it also indexes one hundred eighty degrees to deposit the pretzel on the conveyor. Both grids are double sided to make progressive indexing possible.

An interesting feature of this lower grid is a lever and cam attachment, which displaces it at right angles to the conveyor to lay two rows of pretzels. This is done where the speed of the baking equipment does not demand more than half of the maximum speed of the machine. Thus, an oven conveyor forty-six inches wide, traveling at a speed to take twenty-four pretzels per machine per minute, can be filled to capacity using only seven double-row machines, operating at forty-eight per minute, in place of fourteen machines operating at a reduced speed.

Wherever possible, identical parts have been used to perform like functions. Thus, the pawls and ratchets which index the dough receiver and the upper and lower forming grids are made from the same drawings, with the exception of the ratchet race of the dough receiver, which has reverse rotation with respect to the former two. Details of the ratchet gear are shown in *Fig.* 9. Driving pawls in each case are coupled directly to the end of the driven shaft, while the gear and ratchet supply the power through a segment gear and lever linkage from the actuating cams. Likewise, the positioning and holding of the indexed dough receiver, starwheel and upper and lower grids are accomplished by the same detent pin and guide assemblies throughout. This multiple use of parts is of considerable value because of the limited production of specialized machinery of this type, where the setup time in most cases is far in excess of running time.

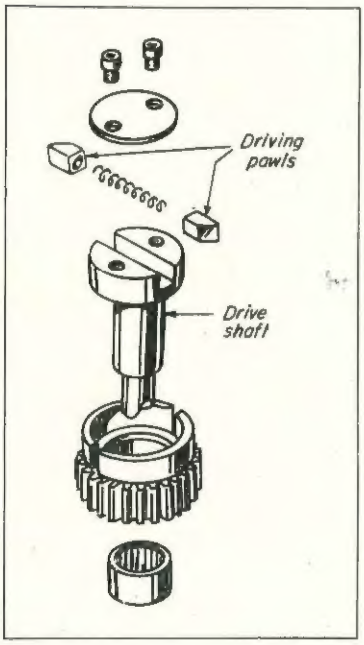


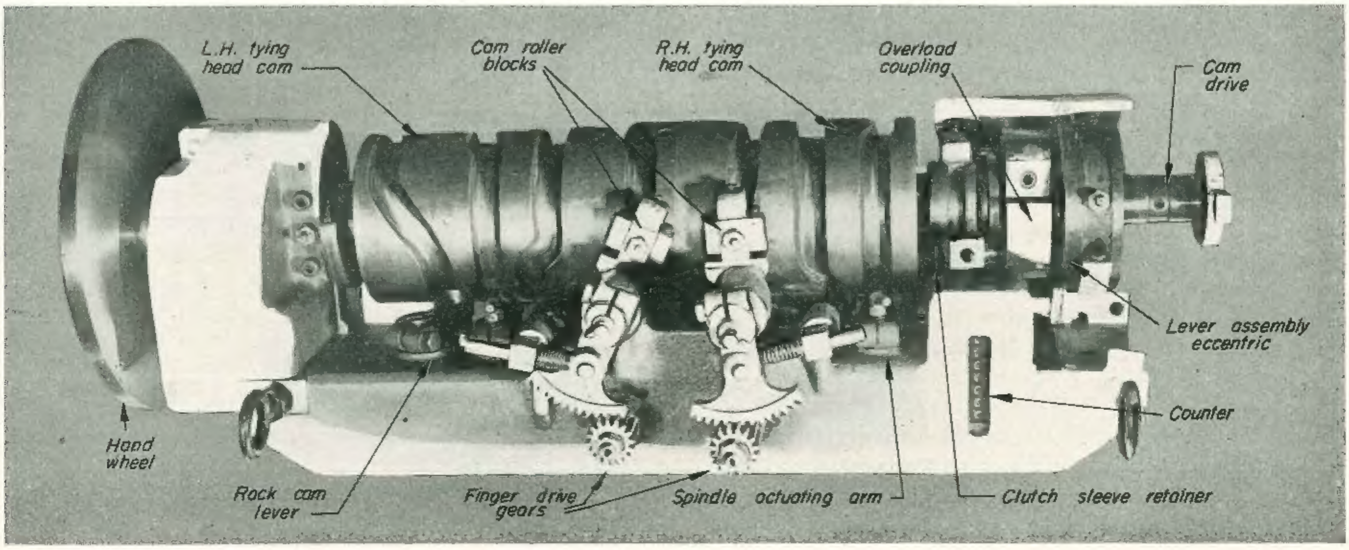
Fig. 9—Left — Typical gear and ratchet used to index the dough-rod receiver and pretzel forming grids

Fig. 10—Below — Top view of tying head, showing cylindrical cam which generates tying finger motions. Right-hand frame cap removed to show clutch detail

Camshaft Controls Finger Motions

All motions of the tying fingers and staking bars are derived from the main cam shaft, *Fig.* 10. Seven cam tracks are machined in two Meehanite castings which form the right and left sections of the assembly. Each section is pinned to the driveshaft separately, the correct relation between the two being established by keys.

An aluminum gear box in front of the cam mounts all of the levers and followers, as well as the tying fingers themselves, making this an easily interchanged assembly. Four Allen cap screws and two dowels support the box rigidly between the side frames which house the main bearings of the cam shaft. In *Fig.*



11 the cover of the gear box is removed to show the compact arrangement of parts in this small space.

The cam track at the far left in *Fig.* 10 actuates a rack extending across the driving spur and segments which rotate the bobber cases. A lever at the right-hand end of the rack attaches to the shaft of a counter to record the number of operations upon which machine rental fecs are based.

Turns and Elevates Bobber Cases

The second cam track from the left and the first on the right elevate and lower the bobber cases of the tying fingers. A yoke at the end of each lever holds a pair of shoes in a track on the outer shaft of the cases. This permits the bobbers to be turned and elevated at the same time after the dough rod has been grasped by the fingers. These bobbers are mounted on and turned by an external shaft, while the finger rotation is accomplished by means of an internal shaft. The inner shafts of the bobber cases extend through the top of the gear box where they are driven by spur gears in mesh with the bronze segment. These two segments are actuated by the levers and followers seen in the top view of the cam and gear box, *Fig.* 10.

Immediately adjacent to the segments are seen the spring posts and springs which compensate for backlash in this part of the gear train. Since the spur gears raise and lower with the vertical motions of the bobbers, they subject the segment gear to more than ordinary wear. The backlash accumulation through the entire gear train from cam lever to tying fingers is held to a maximum of 0.013-inch to eliminate whipping of the tying fingers, which would cause them to drop the dough rod. To achieve this, individual gears are checked to a standard mating gear on standard centers for a maximum backlash of 0.0015-inch.

The staking bars ride in a bronze sleeve block mounted on the back of the gear box. The stamper feet which contact the dough are fastened to the staking bars through a spring-loaded swivel block, *Fig.* 7. This minimizes wear on the inner surfaces of the fingers caused by inaccurate finger stroke adjustments and permits a certain amount of backlash in the finger-operation gear train.

Overload Clutch Protects Mechanism

At the right-hand side of the main cam is located the combination manual and overload-operated clutch, *Fig.* 10. The overload feature of this clutch is of

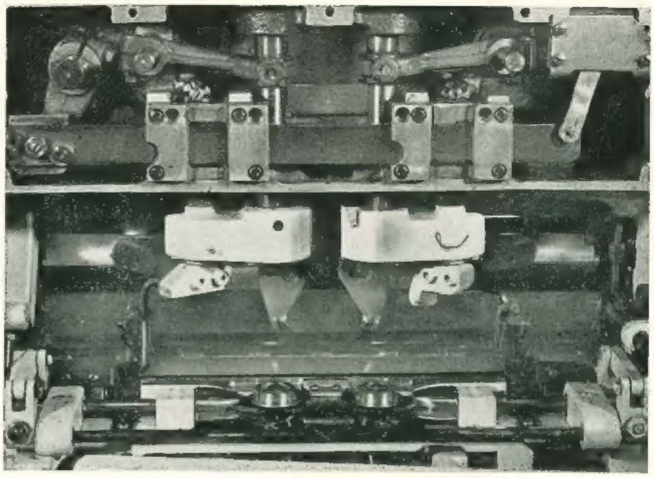


Fig. 11—Removing main gear box cover gives access to the levers and rack which elevate and rotate bobber cases

paramount importance, considering the amount of moving machinery from which the operators cannot otherwise be protected. Details of this clutch were shown in *Fig.* 4. Spring pressure on the detents holding the driving pins is adjusted to allow the clutch to disengage when a force of about twenty pounds is applied against the rotation of the bobber cases. The clutch must be reset manually by means of the hand lever and must be manually disengaged whenever the machine is not tying pretzels. Otherwise the counter would operate with each cycle of the main camshaft.

Adjacent to the left-hand end of the main cam, *Fig.* 10, is a cam which operates the dough-rod trimmer knives. This cam elevates the shear action knives at the ends of the pretzel-forming platen just rapidly enough to permit placement of the dough rod by the starwheel. However, it has an instantaneous drop-off to shear the dough ends before the fingers start to elevate and twist the end loops of the pretzel.

Necessity for a variety of intermittent, reciprocating and precisely timed motions, combined with the necessity for handling a wide range of dough mixtures under extreme variations of relative humidity, created a host of problems in the design of this machine. Also to be taken into consideration were the normal locale of the machine in atmospheres containing flour and salt, plus the fact that lubrication, protective plating and materials contacting the dough had to be scrutinized from the viewpoint of the various federal, state and local pure food laws. With the solution of these problems, the art of twisting pretzels mechanically has become another in the long list of achievements of the Machine Age.

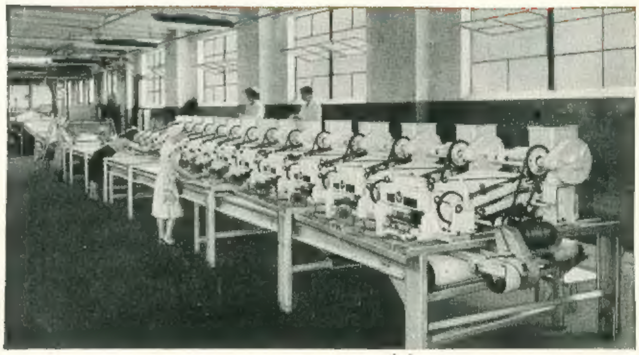
Life-size portrait of an AMF-made Pretzel

...MACHINE MADE
...BAKED
...DRIED

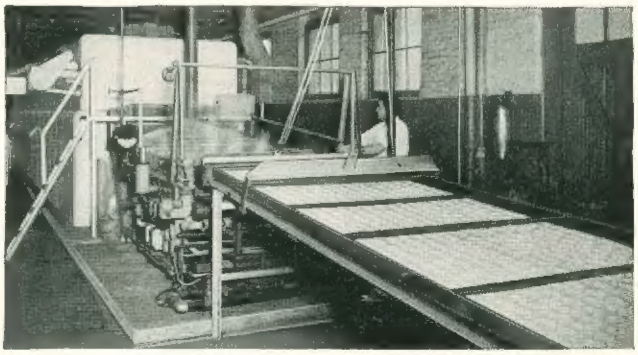
at BECKER'S, BALTIMORE

● The Pretzel Industry has its eyes on Becker Pretzel Bakeries, Inc., Baltimore, Md., for several generations one of the leading pretzel bakeries in the United States. Here, 15 AMF Pretzel Making Machines feed 356,400 pretzels in an 8-hour shift into an AMF Direct Gas-Fired Pretzel Oven. Baked to a beautiful nut brown color in their 90-foot passage through the Oven, they return through the AMF Drying Kiln on the upper tier of the Oven, which dries them to delectable pretzel-crunchy perfection.

● You will find a lucrative field for expansion in highly mechanized pretzel production. For full details, write the Bakery Division, American Machine & Foundry Company, 485 Fifth Avenue, New York 17, N.Y.



A battery of 15 AMF Pretzel Making Machines tie 44,550 pretzels an hour . . . *automatically!*



From the AMF Pretzel Making Machines, a conveyor carries the pretzels to the pretzel cooker and then into the direct gas-fired AMF Oven. They return through the AMF Drying Kiln on the upper tier of the oven. *Photos courtesy Consolidated Gas Electric Light and Power Company of Baltimore.*

PRETZEL MAKING MACHINES, COOKERS, OVENS & DRYING KILNS

DM-671—Printed in U.S.A.